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Tectonic evolution of the Makran-Sistan triple junction: Field study and magnetostratigraphy from the Molasse-type Karvandar Basin, SE Iran

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The Cenozoic Karvandar Basin is situated at the intersection of the Sistan Suture Zone and the Makran accretionary wedge, in SE Iran. This intersection represents the junction of the continental Lut and Afghan/Helmand blocks in the west and east, respectively, and the northward subducting oceanic lithosphere of the Arabian plate in the south, hereafter called Makran-Sistan triple junction. The plate tectonic framework in Late Cretaceous is comparable to the present situation in the Mediterranean, with several microcontinents divided by smaller branches of the Neo-Tethys (Nain-Baft, Fannuj, Sistan, and Sabsevar oceans) surrounding the Central Iranian Blocks and the main Neo-Tethys Ocean to the south.

The Karvandar Basin hosts a series of elongated, doubly-plunging growth synclines connected by variably thick shale walls while anticlinal structures are mostly absent. In this study, we unravel the tectonostratigraphic development of these synclines by geologic field investigations and precise magnetostratigraphic dating, pinpointed by U-Pb zircon ages of interlayered tuffs. Detailed information on the timing of sediment accumulation, limb rotation, and the geometry of unconformities allow identifying the character of their formation, i.e. gravitational downbuilding vs. tectonic forcing, and help understanding the tectonic context of the Karvandar Basin, specifically, how it relates to adjacent plate boundaries such as the Makran subduction zone and the Sistan Suture Zone, which is still under debate.

The stratigraphic record of the Karvandar Basin is dominated by a 6-kilometer-thick sequence, showing a gentle deepening towards the west. The basin records a relatively rapid shallowing upwards trend at the base. After this first phase, the record is dominated by shallow marine to non-marine alluvial Molasse-like sediments. During this phase, the sedimentary environment remained steady for thousands of meters, suggesting a balance between accommodation and sedimentation. This reveals a fast and steady subsiding system, and points to high sedimentation rates and an expanded stratigraphy.

Magnetostratigraphic dating of a approx. 4km sedimentary sequence suggests that the basin

formed between ~23–17 Ma, resulting in an accumulation rate of ~1 m/kyr. Angular blocks of volcanic heritage and corrals in the underlaying shale potentially suggest an olistostrome nature with a respective age >24 Ma. We propose that the closure of the South Sistan Basin and the related orogeny led to tectonic subsidence, where a Molasse-type continental sequence was deposited onto a kilometer-thick, mechanically weak olistostrome.